U.S. FISH AND WILDLIFE SERVICE
SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

SCIENTIFIC NAME: *Notropis oxyrhynchus* Hubbs and Bonham

COMMON NAME: sharpnose shiner

LEAD REGION: Region 2

INFORMATION CURRENT AS OF: October 14, 2005

STATUS/ACTION:

___ Species assessment - determined species did not meet the definition of endangered or threatened under the Act and, therefore, was not elevated to Candidate status
___ New candidate
_X_ Continuing candidate
___ Non-petitioned
_X_ Petitioned - Date petition received: May 11, 2004
_ 90-day positive - FR date:
_ 12-month warranted but precluded - FR date:
_ Did the petition requesting a reclassification of a listed species?

FOR PETITIONED CANDIDATE SPECIES:
a. Is listing warranted (if yes, see summary of threats below)? Yes
b. To date, has publication of a proposal to list been precluded by other higher priority listing actions? Yes
c. If the answer to a. and b. is "yes", provide an explanation of why the action is precluded.
During the past 12 months, almost our entire national listing budget has been consumed by work on various listing actions to comply with court orders and court-approved settlement agreements, emergency listings, and essential litigation-related, administrative, and program management functions. We will continue to monitor the status of this species as new information becomes available. This review will determine if a change in status is warranted, including the need to make prompt use of emergency listing procedures. For information on listing actions taken over the 12 months, see the discussion of "Progress on Revising the Lists," in the current CNOR which can be viewed on our Internet website (http://endangered.fws.gov/).
___ Listing priority change
Former LP: ___
New LP: ___
Date when the species first became a Candidate (as currently defined): June 13, 2002

___ Candidate removal: Former LP: ___
___ A – Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or

continuance of candidate status.

___U – Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.

___ F – Range is no longer a U.S. territory.

___ I – Insufficient information exists on biological vulnerability and threats to support listing.

___ M – Taxon mistakenly included in past notice of review.

___ N – Taxon does not meet the Act's definition of "species."

___ X – Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Fish, Cyprinidae

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Texas

CURRENT STATES/ COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: Texas

LAND OWNERSHIP: The sharpnose shiner occurs in rivers and streams that are owned by the State of Texas. The majority of the riparian land ownership within the documented range of the shiner is private, with minor areas owned by the State (parks), and Federal (Corps of Engineers) governments.

LEAD REGION CONTACT: Susan Jacobsen, 505-248-6641

LEAD FIELD OFFICE CONTACT: Arlington, Texas Field Office, Omar Bocanegra, 817-277-1100

BIOLOGICAL INFORMATION

Species Description: The sharpnose shiner (*Notropis oxyrhynchus*) is a small, slender minnow, endemic to the Brazos River Basin in Texas (Hubbs et al., 1991). Adult sharpnose shiners are approximately 30 to 50 millimeters (1.2 to 2.0 inches [in]) in standard length, have a strongly curved ventral contour, oblique mouth, and pointed snout (Hubbs and Bonham, 1951). They are silver in color, with a faint lateral stripe extending from the gills to the tail. The anal fin is slightly falcate and usually has no more than nine rays; the dorsal fin has eight rays and begins behind the insertion of the pelvic fin (Hubbs and Bonham, 1951).

Taxonomy: The sharpnose shiner was first collected from the Brazos River in 1938, but was not described until 1951 by Hubbs and Bonham, who speculated that its closest relative was *N. percobromus* (= *atherinoides*), which occurs in the Red River system to the north of the Brazos River drainage and in systems to the east (Gilbert, 1980). Phylogenetic analysis of the subgenus *Notropis* also indicates a close relationship between the sharpnose shiner and *N. atherinoides* (Bielawski and Gold, 2001). A review of the current literature indicates the species is still a valid taxon (e.g., Nelson et al., 2004).

Habitat: Sharpnose shiners are obligate riverine fish that occur in fairly shallow water (38 to 82

centimeters [15 to 32 in] in depth) in broad, open sandy channels with moderate current (Moss and Mayes, 1993). Ostrand (2000) found abiotic factors associated with sharpnose shiner habitat to include specific conductance < 30 mS, relatively high current velocity (> 0.20 m/s)(0.65 feet/s) and high turbidity (> 41 NTU). They generally feed on aquatic invertebrates dominated by dipterans, ostracods, trichopterans, odonata, coleopterans, hemipterans, and various terrestrial arthropods (Marks et al., 2001). They often consume a large amount of sand/silt, which would indicate foraging behavior occurs among the sediment, as well as on drift in the water column (Marks et al., 2001). Very little is known about the life history of this species, though it is assumed to be similar to that of congeners (belonging to the same genus) that inhabit prairie streams such as *N. girardi* (a federally threatened species), *N. bairdi*, and *N. buccula*, which are thought to spawn primarily during flood events (Moore, 1944; Moss and Mayes, 1993).

The Brazos River watershed extends from eastern New Mexico southeasterly to the Gulf of Mexico. The basin is approximately 1,030 kilometers (km)(640 miles [mi]) in length, encompasses approximately 118,103 square km (45,600 square mi) (Dunn and Raines, 2001), ranges in width from 1.6 to 193 km (1.0 to 120 mi), and drains all or portions of 69 counties in Texas (Cronin et al., 1973) and three counties in New Mexico. The predominant land use within the basin is agriculture, dominated by cotton, corn, and sorghum, and open rangeland (Dunn and Raines, 2001). Within the Middle Brazos River Basin, a large percentage of agriculture consists of concentrated animal feeding operations (CAFOs) (Armstrong, 1998).

The Brazos River is a typical prairie stream. The main stem originates in the upper reach from the confluence of the Salt and Double Mountain Forks. The upper region of the watershed is highly variable with regard to flow and often becomes intermittent, forming isolated pools within the channel (Echelle et al., 1972; Ostrand, 2000; Ostrand and Wilde, 2001). The river traverses through the Edwards Plateau Ecosystem and extends southeastward through the East Texas and Texas Gulf Coast Ecosystems (USFWS, 1994).

Since the early 1900s, significant reservoir construction has occurred within the Brazos River Basin. By 1986, 1,165 minor and 13 major reservoirs, three of which occur on the main stem of the Brazos River, were listed in the Texas Natural Resource Conservation Commission's (TNRCC) dam inventory (Dunn and Raines, 2001). From 1941 to 1969, the rate of reservoir construction increased substantially and included Possum Kingdom Reservoir in 1941, Whitney Reservoir in 1951, and Granbury Reservoir in 1969, which are located on the main stem Brazos River, as well as six other major reservoirs within the watershed (Dunn and Raines, 2001). A new reservoir, Alan Henry Reservoir, impounded the Double Mountain Fork of the Brazos River in October 1993 (Wilde and Ostrand, 1999), to serve as a future water supply for the City of Lubbock (LEWPG, 2001). The effects of reservoir construction in the Brazos River Basin since 1953 have resulted in significant temporal changes in its fish assemblage (Anderson et al., 1995; Hubbs et al., 1997; Wilde and Ostrand, 1999).

Historic Range/Distribution: The sharpnose shiner historically occurred throughout the Brazos River system, including the Double Mountain and Salt Forks of the Upper Brazos River drainage, and has also been documented in the South and North Forks of the Wichita River within the Red River Basin (Lewis and Dalquest, 1957; Moss and Mayes, 1993; Wilde et al., 1996). Hubbs and Bonham's (1951) description of the sharpnose shiner (82 specimens

collected) reported the fish at four sites on the main stem Brazos River (Brazos County), as well as in its tributaries the Navasota River and Little Brazos River in Brazos County between 1938 and 1941. An additional collection was made on the Brazos downstream from Towash Creek (Hill/Bosque Counties) in 1940. An introduced population may exist in the Colorado River above Buchanan Reservoir (Hubbs et al., 1991); however, the validity of this population is still in question (e.g., Moss and Mayes, 1993).

A biological study of the Upper Brazos drainage conducted in 1979 for the purposes of analyzing effects of the proposed Brazos River Natural Chloride Control Project estimated a population of 1,611 sharpnose shiners in the Salt Fork of the Brazos River, and a population estimated at 451 individuals from Croton Creek, a tributary of the Salt Fork (Johnson et al., 1982).

Moss and Mayes (1993) conducted an extensive study of the distribution of the sharpnose shiner and smalleye shiner (*N. buccula*) within the Brazos River system. The study included a review of known museum, university, and other collections (from 1951 to 1986) to determine the historical distribution of both species. Their review indicated the sharpnose shiner historically occurred at 15 main stem sites (not including sites from the original description), three sites on the Double Mountain Fork of the Brazos River, nine sites on the Salt Fork of the Brazos River, and two sites on the Wichita River (from 1953 and 1955), which drains into the Red River Basin. The historical collections included specimens from the Upper, Middle, and Lower Brazos River systems (Sellers, 1996), ranging from the upper reaches on the Double Mountain and Salt Forks in Kent County, Texas, to the southernmost site in Fort Bend County, Texas.

Of the historical records of sharpnose shiners from the Brazos River Basin examined by Moss and Mayes (1993), 18 collections were taken from the Upper Brazos River drainage, the majority of which were located on the Double Mountain and Salt Forks of the Brazos River. The Double Mountain Fork samples (one sample from 1951 and three from 1986) consisted of 177 specimens from sites in Kent, Fisher, and Haskell Counties. The Salt Fork collections (two samples from 1951, one from 1953, one from 1984, and six from 1986) contained 1,181 specimens from locations in Kent, Knox, Baylor, and Young Counties. Main stem records from the Upper Brazos included 24 specimens collected from two sites in Young County in 1951 and 1986, and 67 specimens collected from two sites in Palo Pinto County from 1951 to1952.

The remaining 15 historic records include four collections of 90 specimens collected between 1951 and 1953 from the Middle Brazos River (Somervell, Bosque, and McLennan Counties), and 11 records collected from the Lower Brazos River. The Lower Brazos River collections include 947 specimens collected between 1951 and 1967 from six sites in Brazos, Burleson, Grimes, Waller, and Fort Bend Counties and 268 specimens collected between 1970 and 1986 from five sites in Robertson, Brazos, Waller, and Washington Counties.

Current Range/Distribution: Moss and Mayes' (1993) assessment of the declining distribution of the sharpnose shiner within the Brazos River Basin was based on the historical records compared with their sampling of the basin from October 1988 through August 1991. Sampling sites were selected based on all known localities of the smalleye shiner within the basin (37 sites), most of which (26 sites) were located in the Upper Brazos River Basin, including 24 sites upstream of

Possum Kingdom Reservoir. From these upstream samples, a total of 2,056 sharpnose shiners were collected from seven sites on the Salt Fork (Stonewall, Knox, Baylor, and Young Counties), three sites on the Double Mountain Fork (Kent, Fisher, and Stonewall Counties), and three sites on the North Fork Double Mountain Fork (Garza County). Two sites sampled in the main stem Upper Brazos below Possum Kingdom Reservoir in Palo Pinto County did not include sharpnose shiners.

Additional surveys within the Upper Brazos drainage that failed to collect sharpnose shiner include collections from Croton Creek (Kent County), which drains into the Salt Fork of the Brazos River, and two sites on the Clear Fork of the Brazos River (Shackelford and Fisher Counties). The sharpnose shiner historically occurred in Croton Creek, but has apparently never been documented from the Clear Fork.

The remaining 11 sampling sites were located within the Middle (Parker and Falls Counties) and Lower Brazos River Basin (Milam, Brazos, Washington, Austin, Fort Bend, and Bell Counties). These sampling efforts produced only 27 specimens from six sites within the Lower Brazos River. Sampling was also conducted within the Red River Basin on the Wichita River (Baylor and Wichita Counties), North Wichita River (Knox County), and South Wichita River (Knox County), but no shiners were collected. While the sharpnose shiner may have been native to the Wichita River, it has not been collected since the 1950s and is likely extirpated from that river (Moss and Mayes, 1993; Wilde et al., 1996).

Current information on the status of the sharpnose shiner continues to show a drastic contrast between the Upper Brazos (upstream of Possum Kingdom Reservoir) and Middle/Lower Brazos River. Extensive sampling at thirteen sites within the Upper Brazos by Ostrand (2000) in 1997 and 1998, produced 2,791 sharpnose shiners at 10 sites (Garza, Kent, Fisher, Stonewall, and Knox Counties), where they represented one of the seven dominant species. The population of sharpnose shiners upstream from Possum Kingdom Reservoir is estimated to represent 8% of the fish assemblage (Ostrand, 2000).

Downstream of Possum Kingdom Reservoir, the population of sharpnose shiners has apparently declined to a fraction of the historic abundance. Since Moss and Mayes' (1993) survey of the Middle and Lower Brazos River system which produced only 27 specimens, limited research has been conducted in this region. Sampling efforts in 1993 and 1994 reported two sharpnose shiner specimens from the lower Brazos River in Robertson/Milam Counties; however, these studies did not produce any other sharpnose shiners within the river (Linam et al., 1994; Sellers, 1996). In the mid 1990s, collecting efforts at a single site on the lower Brazos River (Burleson/Brazos Counties) yielded four specimens from two sampling dates in 1993, one specimen from four sampling dates in 1994, and six specimens from three sampling dates in 1995 (Winemiller, unpublished).

Winemiller and Gelwick (1999) sampled 26 sites within the Middle (McLennan and Falls) and Lower (Milam, Robertson, Brazos, Burleson, Washington, Waller, Austin, Fort Bend, Grimes, and Limestone Counties) Brazos River drainages between September and October 1998, including six main stem sites, three sites on the Navasota River, and one site on the Little Brazos River. These collecting efforts produced 53 species of fish; however, no sharpnose shiners were

collected. Surveys conducted specifically for sharpnose shiner in 2000 and 2001 within the Middle (Falls County) and Lower Brazos River (Austin, Brazos, Fort Bend, and Robertson Counties) failed to produce any specimens (Wilde and Bonner, unpublished).

Most recently, surveys conducted in the Lower Brazos River (Austin County) produced three sharpnose shiner within the river at the confluence with Allens Creek in September 2001 (Gelwick and Li, 2002). In 2003 and 2004, fish samples from the Lower Brazos River (Brazoria, Burleson, and Washington Counties) reported 51 species from over 150,000 individuals collected, eight of which were sharpnose shiner (Winemiller et al., 2004). These surveys were affiliated with the planning process for the proposed Allens Creek Reservoir project.

Historically, the sharpnose shiner existed throughout the Brazos River and several of its major tributaries within the watershed, as well as the Wichita River within the Red River watershed. Current information indicates that the population within the Upper Brazos River drainage (upstream of Possum Kingdom Reservoir) is apparently stable, while the population within the Middle and Lower Brazos River Basins may only exist in remnant areas of suitable habitat, or may be completely extirpated, and the population within the Wichita River is completely extirpated, representing a reduction of approximately 69% of its historical range.

THREATS

A. <u>The present or threatened destruction, modification, or curtailment of its habitat or range</u>. The most significant threat to the existence of the sharpnose shiner is the present and continued modification of its habitat attributable to anthropogenic factors. These factors include reservoir construction, in-stream sand and gravel mining, irrigation and water diversion, sedimentation, industrial and municipal discharges, agricultural activities, and the spread of invasive saltcedar.

Reservoirs - River impoundments often adversely affect downstream fisheries by altering temperature regimes, flow rates, substrate, water quality, and nutrient availability (Anderson et al., 1983; Baxter, 1977). The downstream effects of impoundments often create a benign habitat within the channel, restricting its use to those species that proliferate in deep, incised channels. The significant changes to fish assemblages, including the local extinction of species, produced by downstream effects have been well documented (Gore and Bryant, 1986; Anderson et al., 1983). Reservoirs also fragment riverine habitat prohibiting the completion of the life cycle for those species that require an unimpeded stream for spawning and/or migration.

The downstream effects of reservoirs have altered the habitat within the Brazos River, impacting the fish assemblage. The Morris Sheppard Dam, which impounds Possum Kingdom Reservoir, incorporates hydroelectric generators, which utilize stored water through releases from the dam dependent on pool elevation and local power needs. These hypolimnial releases have modified the thermal regime up to 120 kilometers downstream and along with the associated chemical modifications, are likely responsible for the extirpation of at least four species of fish in the downstream reach (Anderson et al., 1983). In addition to the thermal and chemical alterations affecting fish assemblages, flow regime regulated by dams restricts habitat availability for many fish species (Bain et al., 1988). The marked decrease in fish diversity and decrease in abundance of cyprinids documented within the Brazos River Basin are also likely due to habitat

modifications such as reservoir construction (Anderson et al., 1995).

Changes in channel morphology and substrate have also taken place within the Brazos River due to major impoundments (e.g., Allen et al., 1989; Gillespie and Giardino, 1997). Restriction of natural stream flow and sediment transport often contributes to channel incision and narrowing. The transport of sand through the Brazos River system has decreased in part due to reservoirs (Mathewson and Minter, 1981; Dunn and Raines, 2001). Mathewson and Minter (1981) suggested that the major reservoirs trap approximately 76% of all sand produced within the Brazos River Basin.

Collections made by Moss and Mayes (1993) revealed a distinct difference between the fish assemblage upstream and downstream from Possum Kingdom Reservoir. They suggested that the effects of reservoir construction on the downstream channel have modified the habitat, excluding many native prairie minnows while generalist cyprinids have prospered. Anderson et al. (1983) noted the change created by the construction of the reservoir from sandy bottom and high turbidity (typical sharpnose shiner habitat) to clear, gravel bottom habitat for a distance of 30 km (19 mi) downstream from the Morris Sheppard Dam. Within this reach, seven species not normally found in the non-impacted reaches of the Brazos River (i.e., upstream from the reservoir), including two exotic species, had invaded the modified channel (Anderson et al., 1983).

In addition to the impacts Possum Kingdom Reservoir has created within the Brazos River, two other impoundments occur on the main stem Brazos. Granbury Reservoir, located approximately 258 km (160 mi) downstream from Possum Kingdom, and Whitney Reservoir, located approximately 92 km (57 mi) downstream from Granbury, have altered the habitat within the Middle and Lower Brazos River, which is most likely no longer suitable for the sharpnose shiner.

Reservoir construction on rivers also affects instream habitat and biotic communities upstream of the impoundment, which may include the extirpation of obligate riverine fish (e.g., Winston et al., 1991). Ecological imbalances can occur when facultative riverine fish propagate in reservoirs and disperse into upstream reaches (Winston et al., 1991). Impoundments also present a barrier, preventing upstream migration and/or dispersal, and may cause local extirpations in upstream areas (i.e., headwaters) subject to drought or other natural disturbances (Wilde and Ostrand, 1999).

A study of the effects of the recently constructed Alan Henry Reservoir on the Double Mountain Fork of the Brazos River (Garza County) on prairie stream fish was performed by Wilde and Ostrand (1999). This segment of the Double Mountain Fork is in a semi-arid region (precipitation 46-71 cm/yr) where flow is intermittent and dependent on rain events. During the absence of flow, the stream is characterized by isolated pools that provide the only habitat for fish until the next rain event, which may not occur for several months. Following the impoundment of the river, the upstream reach showed a dramatic change in the fish assemblage, including a decrease in cyprinids and increase in abundance of cyprinodontids (Wilde and Ostrand, 1999). This study indicated that at least two fish species have, or will be, extirpated from the upstream reach. The disappearance of the fish is attributed to the lack of reproduction

and/or survivorship occurring in isolated pools combined with the inability of the downstream population to recolonize the area due to the barrier created by the impoundment.

Future Reservoir Development - As required by Senate Bill 1 (enacted by the 75th Texas Legislature in 1997), Water Planning Regions within the State of Texas have developed and finalized Regional Water Plans for the purpose of addressing future water needs. The Regional Water Plans are incorporated into an overall State Water Plan addressing water management, development, and conservation for the 50-year period from 2000 to 2050.

The majority of the Brazos River Basin falls within the Regions G (Brazos) and O (Llano Estacado) Water Planning Areas. Among the water management strategies detailed in the Region G Water Plan, one major reservoir and five minor reservoirs are recommended for providing water supply for the region (TWDB, 2002). The proposed Little River Reservoir would be located in Milam County on the Little River just upstream from the confluence with the Brazos River and would store between 180,000 and 903,000 acre-feet of water. The five minor off-channel reservoirs within Region G are Meridian, Somervell, Groesbeck, New Throckmorton, and Brushy Creek. The water rights for Groesbeck Reservoir have been obtained and authorize the diversion of 2,500 acre-feet of water per year from the Navasota River in Limestone County.

In addition to these potential reservoir projects recommended in the State Water Plan, several potential reservoirs are included in the Region G Plan for consideration during subsequent planning cycles or to meet water supply needs beyond the year 2050. They are as follows:

- Breckenridge Reservoir (= Reynolds Bend), would be located in Throckmorton County and impound the Clear Fork of the Brazos River just downstream from the confluence with Paint Creek and is anticipated to store 600,000 acre feet of water;

- South Bend Reservoir, would be located in Young County immediately upstream from the confluence of the main stem and the Clear Fork of the Brazos River, capturing flow from both channels, and storing up to 745,800 acre feet of water;

- Paluxy Reservoir in Somervell County, would impound the Paluxy River, a tributary of the Brazos, and store 99,700 acre-feet of water;

- Bosque Reservoir, would be located in Bosque County on the North Bosque River, a tributary of the Brazos, approximately four miles upstream from the City of Meridian and would store 102,900 acre-feet of water;

- Millican Reservoir, which was originally authorized by the U. S. Congress in 1968 and has subsequently been studied for feasibility at two sites on the Navasota River; the Panther Creek site located approximately 13 miles southeast of the City of Bryan (Brazos, Madison, and Grimes Counties) would store 1,973,000 acre-feet of water, and the Bundic Dam site, located between SH 21 and US 79 (Brazos, Robertson, Madison, and Leon Counties) would store 228,000 acre-feet of water;

- Peach Creek Reservoir, would be located in Brazos County and impound Peach Creek and

divert water from the Navasota River for the storage of 14,511 acre-feet of water;

- Little River Off-Channel Reservoir would be constructed on Beaver Creek, a tributary of the Little River, and store 202,500 acre-feet of water;

- and Double Mountain Fork Reservoir, would be located on Double Mountain Fork upstream from the confluence with the Salt Fork and would have a storage capacity between 215,254 and 280,417 acre-feet (BGWPG, 2001, TWDB, 2002).

The water management strategies for the Region O Planning Area include the construction of Post Reservoir on the North Fork Double Mountain Fork of the Brazos River in Garza County (LEWPG, 2001). Post Reservoir has been authorized by the Texas Commission on Environmental Quality (TCEQ), with a permit recently extended to allow completion by 2012, and would impound 57,420 acre-feet of water.

An additional major reservoir within the Brazos River drainage is included within the Region H Water Plan and has been authorized by the TCEQ. The proposed Allens Creek Reservoir would be located on Allens Creek just upstream from its confluence with the Brazos River in Austin County. It would impound more than 200,000 acre-feet of water and would divert water directly from the Brazos River (RHWPG, 2001).

The historical habitat within the Middle and Lower Brazos River has effectively been converted from habitat that once supported the sharpnose shiner to habitat comprised of thermal, physical, and morphological parameters no longer suitable to the shiner, largely resulting from impoundments within the basin. Although current records of the fish from the main stem downstream of Possum Kingdom Reservoir are sparse, remnant populations may still exist in areas of suitable habitat. However, the suitable habitat remaining may be fragmented to the extent that any surviving populations are no longer viable. The continued effects of the existing impoundments coupled with the potential future water management strategies outlined in the Regional Water Plans seriously discount the possibility of recovery of the shiner in the Middle and Lower Brazos River.

Within the Upper Brazos River system, sharpnose shiners are most common within the higher order streams (Ostrand, 2000) with suitable flow and conductivity. The flow within the headwater reaches of the Double Mountain and Salt Forks is intermittent and often restricted to large pools within the channel. Under the harsh conditions that accompany non-flow periods, sharpnose shiners are the first species to be eliminated within the pools (Ostrand and Wilde, 2001).

The isolated pools of the Upper Brazos tributaries are unlikely suitable for successful reproduction of the sharpnose shiner. Its persistence in these upper reaches is most likely the result of recolonization from populations occurring downstream during times of normal flow (Wilde and Ostrand, 1999; Ostrand and Wilde, 2001). However, the headwaters may be significant to the reproductive success of the shiner. Reproduction may be triggered by flood events, allowing shiners to move into the headwaters where eggs would be released and transported by currents downstream to perennial areas (Wilde, pers. comm.). Reservoir

construction on the Upper Brazos tributaries would create a barrier between the base population and the upper reaches, preventing recolonization and potentially reducing reproductive success.

The potential Double Mountain Fork and Post Reservoir projects could have significant adverse effects on the stable population of sharpnose shiners within the Upper Brazos. The construction of the John T. Montford Dam, which impounds Alan Henry Reservoir (Garza County), in 1991 resulted in the disappearance of two common fishes within the river's headwaters (Wilde and Ostrand, 1999). A similar situation could occur on the Double Mountain Fork downstream of Alan Henry Reservoir and the North Fork Double Mountain Fork, should the Double Mountain Fork and Post Reservoir projects be implemented. The potential direct impacts to the shiner resulting from construction of these reservoirs include 1) the inundation of occupied habitat, 2) the local extinction of upstream populations, and 3) the loss of habitat downstream from the dams due to the modification of necessary abiotic components (flow regime, thermal regime, substrate, conductivity, etc.).

Chloride Control Reservoirs - The streams of the Upper Brazos River Basin are characterized by natural salts that originate within the salt and gypsum terrain and an underlying brine aquifer within this region. Because the salt entering the Brazos River in this area limits its use as a practical water supply, several studies on the feasibility of salt control have been conducted (e.g., Johnson et al., 1982).

Options within the Region G Water Plan for the control of naturally occurring chlorides include deep well injection of recovered brine from the aquifer and the construction of Kiowa Peak Reservoir for the disposal of recovered brine. The Kiowa Peak Reservoir would be located on North Croton Creek just upstream from the confluence with the main stem Brazos (Stonewall and King Counties) and have a storage capacity of 659,650 acre-feet. The original design and study on Kiowa Peak was done by the U.S. Army Corps of Engineers and included the two additional salt retention reservoirs; Dove, located on Haystack Creek (Stonewall and King Counties), and Croton, located on Croton Creek in Stonewall and Kent Counties (Johnson et al., 1982).

The sharpnose shiner evolved to prosper in the saline and turbid conditions naturally occurring in the Brazos River. The various chloride control projects proposed for the Upper Brazos for the conversion of the natural saline waters to a quality available for human consumption would modify the chemical characteristics conducive to sharpnose shiner habitat. Additionally, those projects that require the construction of brine retention reservoirs may also inundate shiner habitat and reduce instream flows to the major tributaries (i.e., the Salt Fork), as well as the Brazos River proper.

Existing Reservoir Enhancement - An alternative to water management within the Brazos River Basin is expanding the available yield in an existing reservoir by increasing the conservation pool level, water diversion to temporary storage, and construction of a new embankment downstream from the current one. Within the Brazos River Basin, potential Region G projects related to existing reservoir supply include increasing the storage of Leon Reservoir (conservation pool raise) in Eastland County, water diversion from California Creek into Stamford Reservoir (Haskell County), water diversion from Sweetwater Creek into Sweetwater

Reservoir (Nolan County), water diversion from Battle Creek into Cisco Reservoir (Eastland County), increasing the storage of Waco Reservoir in McLennan County, and increasing the storage in Fort Phantom Hill Reservoir (new downstream embankment) in Jones County. These projects would contribute to the documented effects impoundments cause to river systems, especially regarding flow regime, within the existing range of the sharpnose shiner.

Discharges and Sedimentation - In 1996, 329 domestic facilities (i.e., municipal wastewater) and 172 industrial facilities held permits by the state (TNRCC, 1996) within the Brazos River Basin. In 2000, 639 domestic and 350 industrial facilities were permitted within the basin (TNRCC, 2000). Permits held by domestic and industrial facilities allow for the discharge of treated and untreated effluent into the basin. Within the Upper Brazos River drainage alone, the sum of permitted facility discharges is more than 6,670 million gallons of effluent per day (U.S. Fish and Wildlife Service, unpublished data). These discharges modify water quality and add to the continued alteration of the Brazos River channel, affecting its morphology and substrate composition. Adverse conditions within the channel, such as low dissolved oxygen, causing fish kills result from these discharges when sewage facilities fail.

Silt and sediment entering streams via stormwater runoff is a primary source of impairment to surface waters in the United States (USEPA, 2002). The predominant land use within the Brazos River Basin is agriculture. Practices that accompany agricultural operations, including harvesting, tilling, and native vegetation clearing contribute to sediment entering the Brazos River system and the conversion of the natural substrate to silt and mud bottom. This source, along with other development projects involving significant earth disturbance resulting in excessive sedimentation within the Brazos River, reduces the available habitat for the sharpnose shiner.

In 1996, 282 agricultural facilities (i.e., CAFOs) were permitted by the state (TNRCC, 1996) within the Brazos River Basin. The state reported 820 agricultural permits within the basin in 2000 (TNRCC, 2000). The wastes associated with CAFOs are typically high in nutrients (i.e., nitrogen and phosphorus compounds) and historically discharges of these wastes to surface water bodies have resulted in degraded water quality and wildlife mortality (Baker et al., 1998). CAFOs are not permitted to discharge into Waters of the United States except during severe weather events that exceed in intensity a 25-year rainfall event in a 24-hour period. In addition, during periods of intense rainfall and high flooding, retention structures can fail and lead to severe pollution to water bodies, which results in fish kills due to the inability of the watershed to filter or dilute the heavy nutrient load. Although discharge from CAFOs is not allowed by permit under normal conditions, unlawful discharge does occur. For example, from 1993 to 1998, the Environmental Protection Agency (EPA), under the Clean Water Act, documented 24 discharges from permitted CAFOs into Waters of the United States in Texas. Thirteen of these discharges were caused by chronic storm events and reported to the EPA, the remaining eleven were illegal discharges. From 1992 to 1999, the Texas Parks and Wildlife Department investigated over 60 fish kills attributable to anthropogenic causes (sewage discharge, oil spills, fertilizers, pesticides, etc.) and resulting in approximately 1,100,000 mortalities within the Brazos River Basin (TPWD, 2002).

Stormwater discharge and increased sedimentation within the Brazos River resulting from rock

mining may have contributed to habitat degradation in the Middle Brazos River region. Prompted by numerous complaints from private landowners of excessive sedimentation within a portion of the Brazos River in Palo Pinto and Parker Counties, the TCEQ implemented the Clear Streams Initiative to investigate rock mining facilities and determine levels of compliance with existing regulatory requirements (TCEQ, 2004). Although TCEQ's September 2004 report concluded that rock mining facilities did not significantly affect the state's streams, numerous operational violations among permitted and un-permitted facilities were documented. Common violations were inadequate Best Management Practices, unauthorized discharges, and failure to monitor as required by the permit (TCEQ, 2004). The continued operation of un-permitted rock mines and/or un-enforced mine violations occurring within the Brazos River Basin may pose a threat to the sharpnose shiner, especially if these facilities occur within the Upper Brazos River.

In-stream Gravel Mining - Within the Lower Brazos River, sand and gravel operations have mined the channel for many years (Dunn and Raines, 2001). In addition to the obvious short term direct impacts of dredging a river channel for collecting substrate, which may involve draglines, temporary island construction, removal of trees, excavation of settling pits, and heavy machinery within the channel, changes in the aquatic fauna may also occur. Forshage and Carter (1974) found major changes in both macroinvertebrate and fish populations resulting from an in-stream gravel operation within the Brazos River. In the absence of careful planning and appropriate mitigation measures, in-stream mining could also result in long term irreversible effects to the stream (Langer, 2002). The significance of the effects of these operations to the sharpnose shiner is not known.

B. Overutilization for commercial, recreational, scientific, or educational purposes. There is no current information that would suggest sharpnose shiners are over utilized for commercial, recreational, scientific, or educational purposes. Minnows of the genus *Notropis* are undoubtedly used as bait fishes and are probably harvested in the commercial bait industry. Commercial bait harvesters are required to obtain a permit and report annually on the species and numbers collected. However, the permit does not restrict the quantity of nongame fishes that can be harvested, and furthermore, the list of nongame fishes allowed for harvest under the permit specifies "*Notropis spp*.," which is likely the most detail submitted in an annual report. In 2002, four permits were issued for the harvest and sale of minnows from the Brazos River. Only two permittees reported a harvest in 2001. Currently, there is only one active permit for minnow harvest from the Brazos River. The impacts the bait industry may have on the sharpnose shiner are unknown.

C. Disease or predation. The impact of disease or predation upon the sharpnose shiner is not known. The State introduces game fish within the Brazos River and its impoundments, including some exotic species, which likely prey upon sharpnose shiners. However, the extent of the effects of predation has not been determined.

D. The inadequacy of existing regulatory mechanisms. State law does not provide protection for the sharpnose shiner. There are no regulatory mechanisms for persons harvesting these minnows for use as bait fish, with the exception of a State fishing license and Nongame Fish Permit. Permitted individuals are not restricted in quantity for bait fish harvests. See also discussion under Section B.

E. Other natural or manmade factors affecting its continued existence. The Upper Brazos region (upstream of Possum Kingdom Reservoir) is affected by the invasive exotic saltcedar (*Tamarix* sp.). Saltcedar was introduced in the United States from Eurasia as an ornamental plant in the late eighteenth century and has since escaped from cultivation and spread rapidly throughout the southwestern United States (Robinson, 1965). The rapid spread of saltcedar is likely an indirect result of reservoir construction and modification of natural river flows (Kerpez and Smith, 1987). The effects of saltcedar invasion on native ecosystems include, but are not limited to, alteration of stream/groundwater hydrology, displacement of native plant communities, and degradation of wildlife habitat (Kerpez and Smith, 1987). As of 1969, saltcedar was the most extensive flood plain community within the Upper Brazos River from Possum Kingdom Reservoir to the confluence of the Salt and Double Mountain Forks (approx. 521 river km [324 river mi]), covering approximately 28% of the flood plain, (Busby and Schuster, 1971). Blackburn et al. (1982) estimated saltcedar to have occupied 57% of the original Brazos River channel from the confluence of the mainstem and Clear Fork upstream to Seymour, Texas (129 river km [80 river mi]). The establishment of saltcedar in this region has slowed flood water velocity which has resulted in excessive sediment deposition and narrowing of the channel (Blackburn et al., 1982). The average width of this stretch of the river has narrowed from 157 meters (515 ft) in 1941 to 67 meters (220 ft) in 1979 (Blackburn et al., 1982).

The invasion of saltcedar within the Upper Brazos region that has resulted in modification of the channel, excessive sediment deposition, and altered flood stages is a threat to the sharpnose shiner. The sharpnose shiner requires fairly shallow, broad, open sandy channels with moderate current. The effects of dense saltcedar communities along the mainstem, Double Mountain and Salt Forks over time would render its natural habitat unsuitable. The magnitude of this threat is unknown and dependent on the extent and rate of saltcedar encroachment within the entire Upper Brazos River and its major tributaries; however, because the infestation occurs within the portion of the river supporting the majority of the known population shiners, the threat may be significant.

In recent years, the Brazos River has experienced massive blooms of golden algae (*Prymnesium parvum*) resulting in several fish kills. The alga kills by way of toxins released into the water that have a lethal effect on gill-breathing animals. Although little is known about the causes of golden algal blooms, as with many other algae, they may be triggered by excessive nutrient loading from point source and non-point source events such as industrial and municipal discharges and runoff from agricultural operations. The effects of the golden algae may be insignificant, but further information is necessary.

The current limited distribution of the sharpnose shiner within the Upper Brazos River Basin makes it vulnerable to catastrophic events occurring in this region. The shiner maintains populations within the harsh conditions of this area and can recover from droughts, provided the conditions of its habitat remain suitable. Catastrophic events such as the introduction of competitive species or prolonged drought would increase the likelihood of extinction.

The potential for introduction of competitive species is high due to the reports of such unintentional introductions by anglers and commercial bait fishermen. For example, the Red

River shiner (*N. bairdi*) was apparently introduced into the range of the threatened Arkansas River shiner, and may seriously threaten its status. The Red River shiner is currently not known from the Brazos River, however, the probability of introduction is high, since the Red River Basin is immediately to the north of the current population of sharpnose shiners. Currently, there is no evidence that introduced species within the Brazos River effectively compete with the sharpnose shiner.

CONSERVATION MEASURES PLANNED OR IMPLEMENTED: None

SUMMARY OF THREATS: The threats to the sharpnose shiner consist of current and future reservoir development, in-stream sand and gravel mining, industrial and municipal discharges, agricultural activities, irrigation and water diversion, excessive sedimentation, and the spread of invasive saltcedar. Reservoir development within the Brazos River Basin is largely responsible for the modification of habitat within the river that has rendered major portions unsuitable for the sharpnose shiner. The three major impoundments of the Brazos River proper have apparently extirpated the sharpnose shiner from the Middle Brazos region and reduced it to relict populations within the lower portion of the river. Proposed reservoir development within the Upper Brazos region is a significant threat to the extant populations. While only one major reservoir is currently permitted (Post Reservoir), others are included in the Texas State Water Plan as a potential source to meet the demand for water to the year 2050. In-stream sand and gravel mining, excessive sedimentation, and industrial and municipal discharges coupled with the effect of impoundments, reduce the likelihood of the Brazos River sustaining viable populations of the sharpnose shiner downstream of Possum Kingdom Reservoir. Agricultural activities and the demand for water use (i.e., diversion and irrigation) within the Upper Brazos River also threatened the extant populations, especially due to the dry conditions of the region that often result in the lack of flow and isolated pools. The effect of saltcedar within the Upper Brazos region threatens the existing sharpnose shiner habitat. Saltcedar encroachment in the Upper Brazos and tributaries is likely an indirect result of impoundment of the river. These threats combined with the substantial reduction in historic range due to anthropogenic factors justify the candidate status of the sharpnose shiner.

For species that are being removed from candidate status:

___Is the removal based in whole or in part on one or more individual conservation efforts that you determined met the standards in the Policy for Evaluation of Conservation Efforts When Making Listing Decisions (PECE)?

LISTING PRIORITY

THREAT			
Magnitude	Immediacy	Taxonomy	Priority
High	Imminent	Monotypic genus	1
		Species	2
		Subspecies/population	3
	Non-imminent	Monotypic genus	4

		Species Subspecies/population	**5*** 6
Moderate to Low	Imminent	Monotypic genus Species Subspecies/population	7 8 9
	Non-imminent	Monotypic genus Species Subspecies/population	10 11 12

Rationale for listing priority number:

Magnitude: The reduction in the historical distribution of the sharpnose shiner within the Brazos River Drainage is largely attributable to the continued modification of its habitat. The existing modifications to the river may limit the survival of any remaining populations and/or preclude the recovery of the shiner within the Middle and Lower Brazos River. The primary threat to the remaining stable population within the Upper Brazos region is the documented direct and indirect impacts of potential reservoir development within the basin. Currently, two major reservoirs are authorized within the current range of the species. Several additional potential water development projects, including major reservoir sites, desalination, and existing reservoir enhancement, are options for meeting the future water demand in this region. For these reasons, we believe the magnitude of threat to the species is high.

Imminence: The potential water development projects within the Upper Brazos River basin, with the exception of the permitted Post Reservoir, are options for meeting the water needs in the area up to the year 2050 or beyond. Large reservoir development is usually a lengthy process that may extend for several years depending on funding, land acquisition, and local opposition. However, the potential for low-priority water projects to be elevated to high priority during subsequent planning cycles exists depending on many factors. At this time, we consider that the immediacy of threats to the species are best categorized as non-imminent.

__X__ Have you promptly reviewed all of the information received regarding the species for the purpose of determining whether emergency listing is needed? Yes.

Is Emergency Listing Warranted? No. Stable populations of the sharpnose shiner currently exist in unmodified portions of its range.

DESCRIPTION OF MONITORING: Monitoring of the status of the sharpnose shiner currently consists of contact with local fisheries biologists (academic researchers and state biologists) who have expertise on the species. Correspondence was sent to Dr. Timothy Bonner (Texas State University), Dr. Frances Gelwick (Texas A&M University), Gordon Linam (Texas Parks and Wildlife Department [TPWD]), Kevin Mayes (TPWD), Dr. Gene Wilde (Texas Tech University) and Kirk Winemiller (Texas A&M University) on August 30, 2005. This correspondence included specific requests on taxonomy and the threat of saltcedar invasion, and provided the information for obtaining the latest species assessment form. Earlier contact was also made with a subset of this group to inquire on specific research projects within the Brazos River and discuss

the biology of the species and threats to its habitat. Some new information on recent collections and habitat was received from individuals in this group. Bob Gottfried of TPWD was also contacted for the current occurrence information maintained in TPWD's Biological Conservation Database, which was received on July 14, 2005. A literature search is performed at least once annually using two or more abstract databases, as well as an internet search engine, to locate newly published articles related to the species and the Brazos River. In 2004, the TPWD selected a proposal for research on the sharpnose shiner for funding under section 6 of the Endangered Species Act. The study is being conducted by Dr. Gene Wilde of Texas Tech University and will investigate the distribution, status, habitat preference and reproductive ecology of the sharpnose shiner within the Brazos River. This level of monitoring is sufficient to update the status of the species due to the species' endemism to the state and the presence of experts employed with the state agency and local universities.

COORDINATION WITH STATES

Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment: The USFWS biologists within the State of Texas commonly work with their counterparts in the TPWD, the state agency responsible for conservation of Texas' fish and wildlife resources, in coordinating conservation and information on candidate species. As an added gesture, theTPWD was formally offered the chance to submit any outstanding data for the 2006 publication of the Candidiate Notice of Review in an August 29, 2005, letter to the Executive Director of that agency. The TPWD responded to this request by providing species information on the candidates in Texas, however, no new information regarding the sharpnose shiner was available.

Indicate which State(s) did not provide any information or comments: NA

LITERATURE CITED

Allen, P.M., R. Hobbs, and N.D. Maier. 1989. Downstream impacts of a dam on a bedrock fluvial system, Brazos River, central Texas. Bull. Assoc. Eng. Geol. 26(2): 165-189.

Anderson, A. A., C. Hubbs, K. O. Winemiller, and R. J. Edwards. 1995. Texas freshwater fish assemblages following three decades of environmental change. Southwest. Nat. 40(3):314-321.

Anderson, K. A., T. L. Beitinger, and E. G. Zimmerman. 1983. Forage fish assemblages in the Brazos River upstream and downstream from Possum Kingdom Reservoir, Texas. J. Freshwater Ecol. 2(1):81-88.

Armstrong, M. A. 1998. A fishery survey of the middle Brazos River basin in north-central Texas. U.S. Fish and Wildlife Service, Region 2. 72 pp.

Bain, M. B., J. T. Finn, and H. E. Booke. 1988. Streamflow regulation and fish community structure. Ecology 69(2):382-392.

Baker, D. L., J. D. Lusk, and C. M. Giggleman. 1998. Phase II Contaminants Investigation of Buffalo Lake National Wildlife Refuge, Texas 1993-1994. U.S. Fish and Wildlife Service, Arlington, Texas. 35 pp.

Baxter, R.M. 1977. Environmental effects of dams and impoundments. Ann. Rev. Ecol. Syst. 8:255-283.

Bielawski, J.P. and J.R. Gold. 2001. Phylogenetic relationships of cyprinid fishes in the subgenus *Notropis* inferred from nucleotide sequences of the mitochondrially encoded cytochrome *b* gene. Copeia 3:656-667.

Blackburn, W.H., R.W. Knight, and J.L. Schuster. 1982. Saltcedar influence on sedimentation in the Brazos River. J. Soil and Water Conserv. 37:298-301.

Brazos G Regional Water Planning Group (BGWPG). 2001. Brazos G Regional Water Planning Area, Regional Water Plan. Prepared by HDR Engineering, Inc. for the Texas Water Development Board.

Busby, F.E., Jr. and J.L. Schuster. 1971. Woody phreatophyte infestation of the middle Brazos River flood plain. J. Range Mgmt 24:285-287.

Cronin, J. G., C. R. Follett, G. H. Shafer, and P. L. Rettman. 1973. Reconnaissance investigation of the ground-water resources of the Brazos River Basin, Texas. Texas Water Commission Bulletin 6310. 152 pp.

Dunn, D. D. and T. H. Raines. 2001. Indications and potential sources of change in sand transport in the Brazos River, Texas. United States Geological Survey Water-Resources Investigations Report 01-4057. 32 pp.

Echelle, A. A., A. F. Echelle, and L. G. Hill. 1972. Interspecific interactions and limiting factors of abundance and distribution in the Red River pupfish, *Cyprinodon rubrofluviatilis*. Amer. Mid. Nat. 88:109-130.

Forshage, A. and Neil E. Carter. 1974. Effects of gravel dredging on the Brazos River. Southeastern Assoc. of Game and Fish Comm. Proc. 27:695-709.

Gelwick, F.P. and R.Y. Li. 2002. Mesohabitat use and community structure of Brazos River fishes in the vicinity of the proposed Allens Creek Reservoir. Texas Water Development Board (Contract No. 2001-483-376) unpublished report, Austin, Texas.

Gilbert, C. R. 1980. *Notropis oxyrhynchus* Hubbs and Bonham, sharpnose shiner. p. 291 in D.S. Lee et. al. *Atlas of North American Freshwater Fishes*. N. C. State Mus. Nat. Hist., Raleigh. i-x + 854 pp.

Gillespie, B.M. and J.R. Giardino. 1997. The nature of channel planform change: Brazos River, Texas. Tex. J. Sci. 49(2):109-142.

Gore, J. A. and R. M. Bryant. 1986. Changes in fish and benthic macroinvertebrate assemblages along the impounded Arkansas River. J. Freshwater Ecol. 3(3):333-345.

Hubbs, C. L. and K. Bonham. 1951. New cyprinid fishes of the genus *Notropis* from Texas. Tex. J. Sci. 3(1):91-110.

Hubbs, C. L., R. J. Edwards, and G. P. Garrett. 1991. An annotated checklist of the freshwater fishes of Texas, with keys to identification of species. Tex. J. Sci. 43(4) Supplement. 56 pp.

Hubbs, C. L., E. Marsh-Matthews, W. J. Matthews, and A. A. Anderson. 1997. Changes in fish assemblages in east Texas streams from 1953 to 1986. Tex. J. Sci. 49(3) Supplement:67-84.

Johnson, J. L., R. H. Wiley, R. DeArment, B. Spain, and B. Alexander. 1982. Brazos Natural Salt Pollution Control Project, Texas. U. S. Department of the Interior, Fish and Wildlife Service, Region 2, Area 1, Austin, Texas. 41 pp.

Kerpez, T.A. and N.S. Smith, 1987. Saltcedar control for wildlife habitat improvement in the southwestern United States. U.S. Fish and Wildl. Serv. Resour. Publ. 169. 16 pp.

Langer, W.H. 2002. A general overview of the technology of in-stream mining of sand and gravel resources, associated potential environmental impacts, and methods to control potential impacts. U.S.G.S. Open-File Report OF-02-153. 38 pp.

Lewis, D.L. and W.W. Dalquest. 1957. A fisheries survey of the Big Wichita River system and its impoundments. Texas Game and Fish Commission, IF Report Series – No. 2. 64 pp.

Linam, G.W., J.C. Henson, and M.A. Webb. 1994. A fisheries inventory and assessment of Allens Creek and the Brazos River, Austin County, Texas. Texas Parks and Wildlife Department, River Studies Report No. 12. 13 pp.

Llano Estacado Water Planning Group (LEWPG). 2001. Llano Estacado Water Planning Area Regional Water Plan. Prepared by HDR Engineering, Inc. for the Texas Water Development Board.

Marks, D. E., G. R. Wilde, K. G. Ostrand, and P. J. Zwank. 2001. Foods of the smalleye shiner and sharpnose shiner in the upper Brazos River, Texas. Tex. J. Sci. 53(4):327-334.

Mathewson, C. C. and L. L. Minter. 1981. Impact of water resource development on the hydrology and sedimentology of the Brazos River, Texas with implications on shoreline erosion. Bull. Assoc. Eng. Geol.18(1):39-53.

Moore, G. A. 1944. Notes on the early life history of *Notropis girardi*. Copeia 4:209-214.

Moss, R. W. and K. B. Mayes. 1993. Current status of *Notropis buccula* and *Notropis oxyrhynchus* in Texas. River Studies Report 8, Texas Parks and Wildlife Department, Austin. 125 pp.

Nelson, J.S., E.J. Crossman, H. Espinosa-Perez, L.T. Findley, C.R. Gilbert, R.N. Lea, and J.D. Williams. 2004. Common and scientific names of fishes from the United States, Canada, and Mexico. American Fisheries Society, Special Publication 29, Bethesda, MD.

Ostrand, K. G. 2000. Abiotic determinants of fish assemblage structure in the upper Brazos River, Texas. Unpublished PhD dissertation, Texas Tech Univ., Lubbock. 101 pp.

Ostrand, K. G. and G. R. Wilde. 2001. Temperature, dissolved oxygen, and salinity tolerances of five prairie stream fishes and their role in explaining fish assemblages. Trans. Am. Fish. Soc. 130:742-749.

Region H Water Planning Group (RHWPG). 2001. Regional Water Plan. Prepared by Brown & Root/Turner Collie & Braden, Ekistics Corporation, and LBG-Guyton Associates.

Robinson, T.W. 1965. Introduction, spread, and areal extent of saltcedar (*Tamarix*) in the Western States. U.S. Geol. Surv., Prof. Pap. 491-A. 12 pp.

Sellers, K.K. 1996. Survey Report for the Brazos River, 1994. Texas Parks and Wildlife Department Statewide Freshwater Fisheries Monitoring and Management Program, Federal Aid in Sport Fish Restoration Act Project F-30-R. 38 pp.

Texas Commission on Environmental Quality (TCEQ). 2004. Clear Streams Initiative: Report on Investigation/Enforcement Phase, publication AS-196. 103 pp.

Texas Parks and Wildlife Department (TPWD). 2002. Pollution Response Inventory and Species Mortality (PRISM) Database. Compiled by Texas Parks and Wildlife Department Kills and Spills Team, Resource Protection Division, Austin, Texas.

Texas Natural Resource Conservation Commission (TNRCC). 1996. The state of Texas water quality inventory, 13th Edition, Volume 2. 711 pp.

Texas Natural Resource Conservation Commission (TNRCC). 2000. Texas Water Quality Inventory 2000 (SFR-050/00), Volume 3. 131 pp.

Texas Water Development Board (TWDB). 2002. Water for Texas - 2002.

U.S. Environmental Protection Agency (USEPA). 2002. National water quality inventory 2000 report. EPA-841-R-02-001.

U. S. Fish and Wildlife Service (USFWS). 1994. An Ecosystem Approach to Fish and Wildlife Conservation: An Approach to More Effectively Conserve the Nation=s Biodiversity. 14 pp.

Wilde, G. R. personal communication. Texas Tech University, Lubbock, Texas.

Wilde, G. R. and T. H. Bonner. Unpublished. Texas Tech University, Lubbock, Texas; Southwestern State University, San Marcos, Texas.

Wilde, G. R. and K. G. Ostrand. 1999. Changes in the fish assemblage of an intermittent prairie stream upstream from a Texas impoundment. Tex. J. Sci. 51(3): 203-210.

Wilde, G.R., R.R. Weller, C.D. Smith and R. Jimenez, Jr. 1996. Review and synthesis of existing fish collection records for the upper Red River basin upstream from Lake Texoma. Unpublished report submitted to the U.S. Army Corps of Engineers, Tulsa District. 377 pp.

Winemiller, K. O. Unpublished. Texas A&M University, College Station, Texas.

Winemiller, K. O. and F. P. Gelwick. 1999. Assessment of ecological integrity of streams in the Brazos-Navasota River watershed based on biotic indicators. Final Project Report to the Brazos River Authority. 32 pp.

Winemiller, K.O., F.P. Gelwick, T. Bonner, S. Zeug, and C. Williams. 2004. Response of oxbow lake biota to hydrologic exchanges with the Brazos River channel. Unpublished report submitted to Tex. Wat. Develop. Board. 59 pp.

Winston, M. R., C. M. Taylor, and J. Pigg. 1991. Upstream extirpation of four minnow species due to damming of a prairie stream. Trans. Am. Fish. Soc. 120:98-105.

APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve: /s/ Rich McDonald 11/17/2005
Acting Regional Director, Fish and Wildlife Service Date

Concur: _____ August 23, 2006
Director, Fish and Wildlife Service Date

Do not concur: _____
Director, Fish and Wildlife Service Date

Date of annual review: October 2005
Conducted by: Omar Bocanegra